VIII. Appendices

APPENDIX A. POLICY AND INCENTIVES MATRIX

Potential Option	Description of Current Status/Concern	Potential Improvement
ZONING		
Planned Unit Development (PUD) Requirements: CHAPTER 25-2 Division 5		
§2.3.1.C Open Space Required (Tier 1)	Must be 10-20% of project area. Many designers are not aware this may be met using green roof.	Better educate potential development applicants that green roof may be used to meet 10-20% open space requirement.
§2.3.1.D PUD 2-Star Green Building Rating Required (Tier 1)	Projects with green roofs may contribute to up to 4 points on the rating scale. But many designers are not aware of this fact.	Better educate potential development applicants that green roof is means of achieving many points for one system.
		Grant additional points to and/or create additional categories for green roofs.
§2.3.1.H Landscaping (Tier 1)	PUD must exceed standard landscaping requirements. Many designers are not aware this "over and above" landscaping may be met using green roof.	Better educate potential development applicants that green roof may be used to meet additional landscaping requirement.
§2.4 Tier 2 Options	Green roofs not explicitly part of the current tier 2 options, although they could already be counted under "other creative or innovative [environmental] measures."	Explicitly add green roof to Tier 2 list ("other creative or innovative [environmental] measures.").
Zoning Impervious Cover Limits		
§ 25-2-492 Site Development Regulations: Building Cover	Green roofs are currently counted as "building cover" by code. Yet they act and perform as pervious for many social and environmental functions.	Allow increased building cover (BC) if a green roof of a minimum size were provided. Increase Floor-to-Area Ratio (FAR) proportionately.

Anticipated Impacts		City Staff Recommendation
Advantages	**Disadvantages**	
Green roofs may contribute attractive, functional open spaces if designed correctly & accessible.	If green roof not accessible, then open space benefits will be lost.	Recommend staff assemble educational materials for the City's web site and other possible locations. Apply same cap on amount of open space that is not publicly accessible as 25-2-514.
Small effort to increase awareness might result in more green roof projects.	None.	Recommend staff assemble educational materials for the City's web site and other possible locations.
Further incentivize green roofs for Green Building projects.	Green roofs already given multiple points. More would be disproportionate.	Re-write of Water Pt 3: "Stormwater Management" section to acknowledge green roof can be incorporated as part of innovative BMP water quality control system. Other changes not justified at this time.
Green roofs create landscapes in areas normally devoid of them.	Need to ensure that ground-level landscaping is provided per code.	Recommend staff allows green roof to count for landscaping exceeding code requirements. Standard code landscaping must be met at ground level.
Further incentivize green roofs in PUDs.	Not all green roofs will provide net environmental benefits. Need to ensure minimum standards for water quality & conservation met.	Recommend staff educate applicants about possibility of green roof as a Tier 2 option. Subject to meeting conditions ensuring environmental design is provided.
Acknowledges that green roof provides aesthetic, open space & social benefits sought by the zoning BC limits. Would allow more site BC & encourage more green roofs.	Could result in heavy "massing" of buildings on site. Need to ensure that intent of requiring non-building areas respected.	Allow up to 10% extra BC (gross site) with an FAR increase if an equivalent green roof area twice as large is provided (i.e., 2:1 ratio of green roof to increased BC). Need minimum media depth, IPM plan & water conservation plan. Ensure public or private access.

APPENDIX A. POLICY AND INCENTIVES MATRIX

Potential Option	Description of Current Status/Concern	Potential Improvement
Zoning Impervious Cover Limits		
§ 25-2-492 Site Development Regulations: Impervious Cover (IC)	Green roofs are currently counted as "impervious" by code. Yet they act and perform as pervious for many social and environmental functions.	Allow increased zoning impervious cover (IC) if a green roof of a minimum size were provided.
§25-1-23 Impervious Cover Measurement	Subsurface parking structures considered "pervious" if avg. soil depth is 4 feet & min. depth is 2 feet.	Soil and landscaping above a garage is a form of green roof. Explore reduction of 4-foot depth to make more technically & financially feasible.
Density Bonuses		
Downtown Density Bonus Program (under consideration)	Green roofs not explicitly part of the public benefit options, although they could already be counted under Green Building.	Explicitly add green roof to public benefit options. FAR bonuses are used in Portland.
North Burnet-Gateway NP & Airport Blvd. Corridor Density Bonus Programs	Much of the N. Burnet-Gateway Neighborhood Plan & Airport Blvd. corridor areas contribute to significant downstream flooding areas.	Allow greater height and FAR if new development provides a green roof.
Open Space Requirements		
§25-2-514 Open Space Require-ments for Multifamily	Private and, in some cases public, open space is required for many multifamily zoning categories. But it is not widely known that §25-1-21(70) defines open space to include roofs. Green roofs are rarely proposed to meet open space requirements.	Better educate potential development applicants that green roof is means of meeting open space requirements.
Comm. Design Stds §25-2 Subchpt. E, Sec. 2.7 Private Common Open Space & Pedestrian Amenities	Private open space with amenities required on min. 2% of site for all commercial projects over 5 acres. But it is not widely known that §25-1-21(70) defines open space to include roofs. Green roofs are rarely proposed to meet open space requirements.	Better educate potential development applicants that green roof is means of meeting open space requirements.

Anticipated Impacts		City Staff Recommendation
Advantages	**Disadvantages**	
Acknowledges that green roof provides aesthetic, open space & social benefits sought by zoning IC limits. Would allow more site IC & encourage more green roofs.	Could result in heavy "massing" of buildings and IC on site. Need to ensure that intent of requiring pervious/non-building areas respected.	Not recommended. Recommend experimenting with building cover incentives.
Reduction in soil depth reduces cost & increases green roof project feasibility.	Must ensure pervious function of area maintained; groundwater problems and baseflow reduction possible.	Not recommended. Very limited application & need; downside outweighs positives.
Further incentivize green roofs downtown.	Too many options may hinder the effectiveness of the program.	Still under review.
Green roofs on new development could help mitigate flood impacts downstream and boost aesthetics of a currently industrial area.	Ordinance for this area already passed by Council; would require new ordinance.	[Still under review.] Minimum size to have meaningful impact would be necessary. Green roof would be provided in addition to any previous water quality or detention requirement.
Small effort to increase awareness might result in more green roof projects.	If green roof not accessible, then open space benefits will be lost.	Recommend staff assemble educational materials for the City's web site and other possible locations. Ensure common access.
Small effort to increase awareness might result in more green roof projects.	If green roof not accessible, then open space benefits will be lost.	Recommend staff assemble educational materials for the City's web site and other possible locations. Ensure user access.

Potential Option	Description of Current Status/Concern	Potential Improvement
Parkland Dedication		
§25-1-603 Standards for Dedicated Parkland	The Parks director determines whether land offered for parkland dedication (PLD) complies with the standards for dedication. Green roofs have not been considered for PLD but could be, especially where other available public open space is limited.	Better educate potential development applicants that a green roof may potentially be used to meet privately-owned & maintained PLD requirements.
Green Roof Requirement		
Mandatory Requirement	Projects are not required to build a green roof.	Require green roofs for specific building types, geographic areas, or public projects. Some form of mandatory requirements used in Tokyo, Chicago (projects receiving public assistance), and Portland (city-owned facilities).
ENERGY CONSERVATION, AIR QUALITY & CLIMATE PROTECTION		
Energy Code	Austin Energy Code requires a high reflectivity for flat roofs. Exception: vegetated roofs or rooftop pools.	Better define "green roof" to enable AE Credit for reflectivity.
Austin Energy (AE) Rebates associated with Green Roofs	Existing Roof rebate: AE rebates $0.15/sq ft for applying reflective coating on an existing dark roof.	Provide the same $0.30/sq ft rebate for replacing a dark roof with a green roof.

Anticipated Impacts		City Staff Recommendation
Advantages	**Disadvantages**	
A green roof might be the only feasible means of providing parks in built-out areas with little or no existing parkland/open space. It could also increase the attraction of the development (example: amenity roof garden at Whole Foods at 5th & Lamar).	Some green roofs will have access and/or accessibility barriers that will make them unsuitable for use as parks. Some property owners will not want to offer public access.	Recommend consideration of green roofs for privately-owned & maintained parks. Acceptance subject to PARD approval. Green roof must be publicly accessible; provide proper signage & 3 traditional amenities per PLD ordinance. Green roof park would have to have private ownership and maintenance due to dedication and liability issues. (Note: private parks, including potential green roof parks, may receive a max. 50% PLD credit.)
Ensure green roofs used in projects.	Green roofs not necessarily warranted or feasible for every project. Overly prescriptive.	Further demonstration of green roof effectiveness required before this major step should be considered.
Definition of what constitutes a vegetated roof will help plan reviewers assure high performance.	Difficult to strictly define.	Staff asks for GRAG input towards this definition
Potential reduction in consumption & peak energy demand.	When replacing an existing roof, the new roof must meet energy code by providing a high reflectivity or green roof and AE can not justify paying a rebate for meeting and not exceeding code requirements. $0.15/sq ft is an insignificant incentive when considering the cost of green roofs.	Recommend providing $0.15/sq ft for replacing a dark roof with a green roof.

APPENDIX A. POLICY AND INCENTIVES MATRIX

Potential Option	Description of Current Status/Concern	Potential Improvement
Energy Conservation, Air Quality & Climate Protection		
AEGB ratings associated with Green Roofs	All Austin Energy Green Building (AEGB) rating systems promote green roofs within the rating points: * BR3 Roofing to Reduce Heat Island * S6a Site Development Protect or Restore Open Areas * S6b Site Development Maximize Vegetated Open Area * S7b Additional Heat Island reduction - Roof	Grant additional points to and/or create additional categories for green roofs.
Air Quality, Climate Protection & Urban Heat Island Mitigation Program	Urban Heat Island Mitigation funds for tree planting; not yet available for green roofs; community not aware green roofs mitigate rising urban temperatures, air quality pollution, and a/c related energy use.	Create educational outreach campaign & monetary incentives/ rebates for green roofs for Urban Heat Island abatement.
WATERSHED PROTECTION		
Flood Control		
DCM 8.3.4.J Parking Lot Detention	Flood detention requirements may be met on a site using "parking lot detention." This method may not be widely known to design professionals and could be employed on a roof.	Better educate potential development applicants that parking lot detention is an option and could be used in conjunction with a green roof.
25-7-61.A.5.c 2-Year Detention; DCM 1.2.2.D Flood Detention	Green roofs may slow rate and quantity of stormwater runoff to help reduce flood impacts. No credit is currently given.	Assign prorated detention credit for green roof performance and/or assign green roof adjusted Curve Number.

Anticipated Impacts		City Staff Recommendation
Advantages	**Disadvantages**	
Further incentivize green roofs for Green Building projects.	Green roofs already effect multiple points. More would be disproportionate.	Re-write of Water Pt 3: "Stormwater Management" section to acknowledge green roof can be incorporated as part of innovative BMP water quality control system. Other changes not justified at this time. Green roofs affect one Basic Requirement & 4 points. This effort is underway and should be introduced in 2011 version of AEGB rating.
Green roofs provide more urban heat island mitigation than other roof types, reduce energy use, & can remove particulate matter from the air. Increased cooling of surrounding environment benefits community & local ecosystem. Counters conventional dynamic of increased energy use & higher urban temperatures increase the production & incidence of ground level ozone formation & production of carbon.	Cost-benefit ratio for funding green roof may not merit expenditure for developers or owners who are only concerned with their site and not its impact on the larger community environment.	Create educational outreach campaign & monetary incentives/rebates for green roofs. Specifically recommended for application on lower-rise buildings in the CBD & urban core where there is a high percentage of impervious cover.
Saves space on the site to combine the detention footprint on the roof rather than have a separate roof and flood detention pond.	Additional weight of stored water on roof likely to dissuade use of this practice. But may be helpful for parking garages with heavy-duty structural supports.	Recommend staff assemble educational materials for the City's web site to show the various flood control options, including parking lot detention.
Creates incentive to building green roofs; credit should be given if systems perform function. Could help with smaller (2-year) storm detention.	Not likely to be effective for larger (e.g., 10, 25, 100-year) storms. Needs study to demonstrate effectiveness. May require large green roof to have any impact.	Preliminary study being conducted by LBJ Wildflower Center. Follow-up study may also be required.

APPENDIX A. POLICY AND INCENTIVES MATRIX

Potential Option	Description of Current Status/Concern	Potential Improvement
Water Quality (WQ) Structural Control Requirements		
ECM 1.6.7 Innovative Water Quality Controls	Green roofs not considered an approved water quality control for use to meet on-site WQ requirements.	Develop criteria in ECM to allow use of green roof to meet WQ requirements.
		Industry demonstrates that green roof technology can meet water quality requirements.
	Green roof could be used as area for re-irrigation of captured stormwater. Not widely known in design community.	Allow green roof systems to used for re-irrigation component of retention-irrigation systems.
	Biofiltration or other water quality control could be integrated into green roof design. Not widely known in design community.	Incorporate a biofiltration or rain garden (or other approved) system into a green roof design.
Watershed Impervious Cover (IC)		
§ 25-8-63 Impervious Cover Calculations: IC Amount	Green roofs are considered "impervious" just like conventional roofs, despite their ability to absorb and retain rainfall.	Change code to make green roofs (with a minimum media depth) to be considered "pervious."
§ 25-8-63 Impervious Cover Calculations: IC Amount with GR mitigation		Allow increased impervious cover (IC) if a green roof of a certain size were provided, e.g., allow 5% additional IC if a green roof with 10% of the site area were provided. Possibly require retention-irrigation for site WQ control.

Anticipated Impacts		City Staff Recommendation
Advantages	**Disadvantages**	
Creates significant incentive to building green roofs: land and resources for separate WQ control reduced or not required.	Green roof technology not proven in Austin climate to perform as a stand-alone WQ management practice.	Further demonstration of green roof effectiveness required before this major step should be considered.
Same as above. But also does not require City resources.	None to City of Austin. Requires research expenditure on part of green roof industry.	Recommend & encourage research of this type by green roof industry.
Creates incentive to building green roofs: land and resources for separate WQ control reduced or not required. No further code or criteria modifications required. Re-irrigation systems help address water conservation concerns.	Potentially high export of nutrients and high use of potable water need to be prevented. Green roof area may not be large enough to accept all water, requiring supplemental irrigation area (e.g., other landscaping).	Recommend overflow be directed to vegetated area (e.g., rain garden, veg. filter strip, or other landscaping).
Allows water quality requirements to be met in conjunction with green roof with no further code or criteria modifications.	May be more difficult to maintain and inspect a WQ control on a roof. Greater media depth may be structural or financial burden.	Recommend staff assemble educational materials for the City's web site to include the possible integration of a biofiltration system (or other WQ control) on a green roof.
Creates significant incentive to building green roofs: increases functional level of impervious cover allowed.	Green roof technology not proven in Austin climate to perform as natural pervious soils. Issues: (1) typical Green roof soil depths result in more runoff than natural soil profiles; (2) irrigation leads to saturation & thus runoff more like a conventional roof; (3) fertilizers & other landscape products used to care for the Green roof may lead to increased pollutant loads; and (4) lack of connectivity with ground-level soils prevents contributions to groundwater & creek baseflow.	Further demonstration of green roof effectiveness required before this major step should be considered.

APPENDIX A. POLICY AND INCENTIVES MATRIX

Potential Option	Description of Current Status/Concern	Potential Improvement
Watershed Impervious Cover (IC)		
§ 25-8-63 Impervious Cover Calculations: Pct IC for WQ Control Calcs	Green roofs considered "impervious" just like conventional roofs; resulting calculations for water quality control sizing may overstate the amount of runoff and control size required.	Change code to discount a portion of the green roof area for purposes of sizing WQ & flood controls depending on the soil depth and system storage capabilities.
Drainage Utility Fee		
Stormwater Drainage Fee Reduction	Green roofs are considered "impervious" for purposes of calculating the Drainage Utility Fee.	Discount a portion of the green roof area for purposes of calculating the Drainage Utility Fee. Portland, Minneapolis, Seattle & Munster (Germany) use some form of stormwater drainage fee credit.
FINANCIAL INCENTIVES		
Subsidies, Grants, Low-Interest Loans	City does not provide any funding for green roofs.	Provide funding (e.g., subsidies, grants, low-interest loans) for green roofs. Chicago, Montreal, Toronto, & cities in Germany & Switzerland provide some form of funding for green roofs. Portland provides up to $5 per sq ft for green roofs that provide stormwater management as part of their Grey to Green initiative.
Development Process Incentives (Fee Rebates, Expedited Process, Design Support)	City does not provide development process incentives for green roofs.	Provide development process incentives (fee rebates, expedited process, design support) for green roofs. Chicago & Washington D.C. offer expedited review & permit process. Chicago also provides a dedicated review team and fee waiver.
Local Improvement Credits	City does not provide local improvement credits (municipality offers loans for upfront improvement costs and is reimbursed through property taxes over time) for green roofs.	Provide local improvement credits for green roofs. Similar to City of Austin program currently proposed for solar panels.

Anticipated Impacts		City Staff Recommendation
Advantages	**Disadvantages**	
Resulting water quality controls will be smaller and less expensive and will reflect the reality of the site's hydrology.	Increases complexity of oversight to permit. May require monitoring and modeling to confirm assumptions granting discount are justified.	Recommend with time period to evaluate success and accuracy of approach. Use approved model to determine discount.
Further incentivize green roofs. City already provides a discount for proper maintenance of approved water quality controls.	Provides less funds for Drainage Utility. Green roofs need further design improvement to qualify as water quality components (see Innovative WQ Controls above).	Green roofs are already eligible for drainage fee discounts to the extent that they contribute to approved water quality controls. Additional fee incentives not warranted.
Further incentivize green roofs.	Economy in recession: funds not likely available at present. Need to justify why money to be spent on green roofs and not other options.	Review if potential funding becomes available. Will need to weigh advantages of green roofs against those of other worthy environmental & cultural solutions not receiving such a subsidy.
Further incentivize green roofs.	More complicated for Development Review while receiving less money through fees.	Limited design support from City staff may be available, especially for pilot projects. Fee waivers and expedited process not recommended.
Further incentivize green roofs. Shifts cost of green roof off of developer and onto owner (who is receiving long-term benefits - e.g., energy savings).	Economy in recession: funds not likely available at present. Need to justify why money to be spent on green roofs and not other options.	Review if potential funding becomes available. Will need to weigh advantages of green roofs against those of other worthy environmental & cultural solutions not receiving such a subsidy.

Potential Option	Description of Current Status/Concern	Potential Improvement
Financial Incentives		
Property Tax Credit	City does not provide property tax credits for green roofs.	Provide property tax credits for green roofs. New York City offers a one-year property tax credit of up to $100,000.
OVERALL CONSIDERATIONS		
In order to receive credits for the above (open space, zoning impervious cover, water quality, etc.), the following considerations must be adequately addressed: * Water Conservation/Potable Water Use * Integrated Pest Management (IPM) * Minimum soil depth * Minimum green roof size * Suitable plant species * Ongoing maintenance		

Anticipated Impacts		City Staff Recommendation
Advantages	**Disadvantages**	
Further incentivize green roofs.	City receives less property tax revenue. May be difficult to justify in time of economic recession. Need to justify why money to be spent on green roofs and not other options.	Review if budgetary climate supports. Will need to weigh advantages of green roofs against those of other worthy environmental & cultural solutions not receiving such a subsidy.

City of Austin
Founded by Congress, Republic of Texas, 1839
P.O. Box 1088, Austin, Texas 78767

October 14, 2009

From: Green Roof Advisory Group

To: Mayor Lee Leffingwell
Mayor Pro Tem Mike Martinez
Council Member Sheryl Cole
Council Member Bill Spelman
Council Member Laura Morrison
Council Member Randi Shade
Council Member Chris Riley

Re: Downtown Austin Plan – Density Bonus Program
Addition of Green Roofs to Density Bonus Program Public Benefit Options

Dear Mayor and Members of the City Council:

The Green Roof Advisory Group (GRAG) requests that Council **add Green Roofs to the DAP Density Bonus Program Public Benefit Options**, as a separate option with its own criteria. This request is the outcome of the initial efforts of GRAG to research and develop a policy report that includes recommendations regarding credits and incentives to promote green roofs in the city. The group is working with Watershed Protection and Austin Energy to develop performance based standards for green roofs that would establish base lines for consideration.

Green Roofs address a broad range of issues across a breadth of scale, from building to site to urban design, and as such, offer a unique combined Public Benefit in a single technology. As downtown Austin becomes denser, green roofs mitigate the combined negative effects of the built environment. Effectively reconstituting open green space within the building footprint, planted roofs augment the City's green infrastructure, mitigate stormwater runoff, cool ambient temperatures to counteract the urban heat island effect, increase energy conservation, sequester carbon, offer aesthetic amenity, provide wildlife habitat and an opportunity to connect with nature in the heart of the City. The cumulative impact of green roofs in downtown Austin, especially as encouraged and applied in greater numbers with appropriate local technology, stands to be far-reaching.

The Density Bonus Program for the Central City of Portland includes options that incentivize Green Roofs for the benefit of publicly accessible on-site open space and for stormwater management. In Chicago's Density Bonus Program, Green Roofs are promoted to mitigate the effect of the urban heat island and air quality. GRAG is looking to these and other established density bonus programs for criteria and standards relating to green roof design and construction.

At this point, we propose the following Bonus Provisions for Green Roofs in the DAP Density Bonus Program comparable to Portland and Chicago:

- 3-5 s.f. of bonused floor area for each s.f. of green roof (planted roof is a min. of 50% of building footprint)

The current DAP Density Bonus Program proposes Publicly Accessible Open Space as a Public Benefit Option with 5 s.f. of Bonused Floor Area for each 1 s.f. of eligible open space with a 1200 s.f. minimum. However, non-publicly accessible green roofs that would mitigate the urban heat island and provide stormwater management would not fit under this option.

The City of Austin is committed to compliance with the Americans with Disabilities Act.
Reasonable modifications and equal access to communications will be provided upon request.

The Austin Energy Green Building (AEGB) one-star rating system has been proposed as a gatekeeper requirement and additional density may be obtained through projects achieving a two and three-star AEGB rating. While the AEGB currently offers points for vegetated roofs, costs associated with this option (with no added incentives) in comparison to a reflective roof or other green building measures effectively mean that the vegetated roof option is rarely chosen.

Therefore, we believe that a separate Green Roof Public Benefit Option is necessary to promote Green Roofs in the Downtown area for all of the reasons described above. Thank you for consideration of this request. We are willing to assist you in whatever manner is deemed appropriate to add Green Roofs as a Public Benefit in the DAP Density Bonus Program.

Sincerely,

Eleanor H. McKinney

Eleanor McKinney, Chair

Brian Gardiner, Co-Chair

cc:
City Manager Marc Ott
Asst. City Manager Sue Edwards
Asst. City Manager Rudy Garza
City Clerk, Shirley Gentry

The City of Austin is committed to compliance with the Americans with Disabilities Act.
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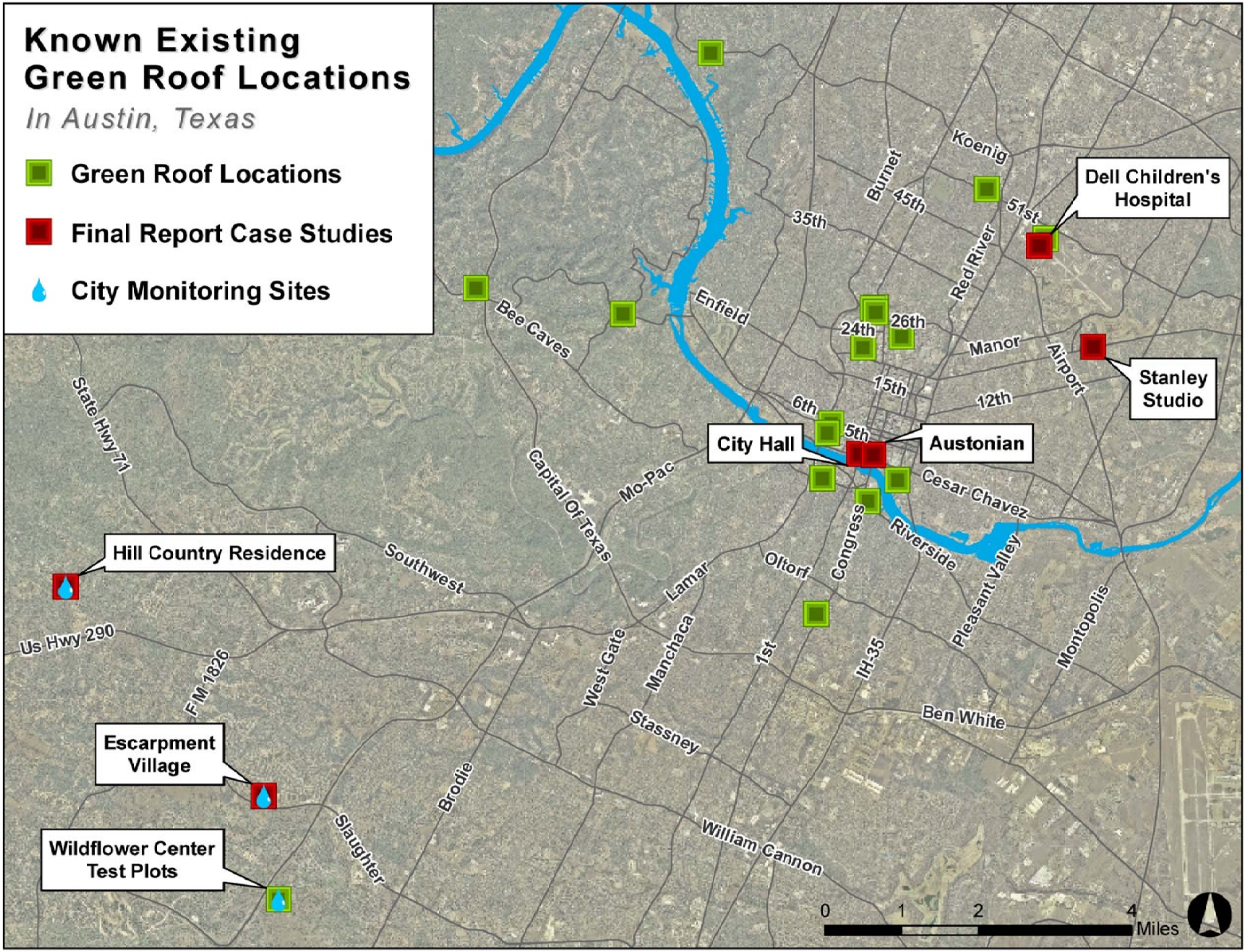
Known Existing Green Roof Locations in Austin, Texas

Name	Address	Type	Case Study	Monitoring
Austin City Hall	301 W. Second St.	Institutional	Yes	
Boyter Bunk House	5125 Bruning Ave.	SF Residential		
Crescent Riverside Apartments	127 E Riverside Dr	MF Residential		
Dell Children's Hospital	4900 Mueller Blvd.	Institutional	Yes	
Escarpment Village Starbucks	9600 Escarpment Blvd.	Commercial	Yes	Yes
Great Outdoors Nursery	2810 S. Congress Ave.	Commercial		
Hill Country Residence	9524 Circle Dr.	SF Residential	Yes	Yes
Jefferson 26	600 W. 26th St.	MF Residential		
Palisades West	6408 Bee Caves Rd.	Commercial		
Residential Project (approximate location)	Barton Springs Rd. and Dawson Rd.	SF Residential		
Residential Project (approximate location)	Mt. Bonnell Rd. and RM 2222	SF Residential		
Residential Project (approximate location)	Westlake Dr. and Redbud Tr.	SF Residential		
Ronald McDonald House	1315 Barbara Jordan Blvd.	Institutional		
Shore Condominiums	603 Davis St.	MF Residential		
Spring Condominium	300 Bowie St.	Mixed Use		
Stanley Studio	1901 E M Franklin Ave.	SF Residential	Yes	
The Austonian	200 Congress Ave.	Mixed Use	Yes	
Welch Hall Plaza	2400 Speedway	Institutional		
West Campus Housing (Cameron House)	2707 Rio Grande St.	Mixed Use		
West Campus Housing (Montgomery House)	2700 Nueces St.	Mixed Use		
West Campus Housing (Sterling House)	709 W. 22nd St.	Mixed Use		
Whole Foods	525 N. Lamar Blvd.	Commercial		
Wildflower Center Research Plots	4801 La Crosse Ave.	Institutional		Yes


Known Existing
Green Roof Locations
In Austin, Texas
Green Roof Locations
Final Report Case Studies
City Monitoring Sites
Dell Children's Hospital
Stanley Studio
City Hall
Austonian
Hill Country Residence
Escarpment Village
Wildflower Center Test Plots
Koenig
Burnet
45th
51st
35th
Red River
Enfield
Bee Caves
24th
26th
Manor
Airport
15th
12th
6th
5th
State Hwy 71
Capital Of Texas
Mo-Pac
Cesar Chavez
Riverside
Southwest
Lamar
Oltorf
Congress
Pleasant Valley
Us Hwy 290
FM 1826
West Gate
Manchaca
1st
IH-35
Montopolis
Ben White
Stassney
Brodie
Slaughter
William Cannon
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CITY OF AUSTIN GREEN ROOF MONITORING EFFORTS

In the summer of 2006 the Water Quality Monitoring Section (WQM) of the City of Austin's (COA) Watershed Protection Department (WPD) began monitoring runoff quantity and quality from a green roof installed in a shopping center (GRE). Monitoring began on a green roof installed at the Hill County Residence (KZE) the following summer.

Runoff

Runoff measurements from the GRE roof were unsuccessful because the drainage area was ill defined. Runoff ratios (Rv), the ratio of runoff depth to rainfall depth, was often greater than 1, which is not possible. After several attempts to revive the data, they were determined to be unusable. (This did not affect the runoff concentration data for the site.)

The runoff measurements at KZE were successful. The average annual runoff ratio from this roof is approximately 0.45, meaning about 45 percent of the rain falling on the roof ends up running off. This is significantly lower—by about one-half—than the runoff from a conventional roof (which would have a runoff ratio of 0.8-1.0).

Studies at the Lady Bird Johnson Wildflower Center (WFC) indicate the design of a green roof plays a significant role in the amount of runoff generated from a roof. The KZE event runoff data indicate that the moisture conditions of the roof also play a critical role. As expected, if the rain event is larger than the storage capacity of the roof, the runoff ratio is increased. This is often the case during rainy periods because the media is at or near its water holding capacity at the start of rainfall. This may also occur if additional water is applied to the media to maintain plant growth. Further study of this aspect of green roofs is being started by WFC and WPD.

Water Quality

The other aspect of green roof runoff is the impact on water quality. WPD collected and analyzed runoff samples for total suspended solids (TSS), volatile suspended solids (VSS), total organic carbon (TOC), chemical oxygen demand (COD), nitrate plus nitrite (NO_3 + NO_2), ammonia (NH_3), dissolved phosphorus (DP), total phosphorus (TP), cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn). See Appendix H for a table detailing the mean runoff concentrations from the two green roofs (assuming lognormal distribution). Concentrations from developed and undeveloped areas are included for reference only.

The solids concentrations (TSS and VSS) are generally lower than those seen elsewhere, however the proportion of non-mineral solids (VSS) to the total is higher. This taken with the measured organics in the runoff (TOC and COD) indicates that there is higher level of organic material (both solid and dissolved) in the runoff from green roofs.

Nitrogen concentrations in the runoff from green roofs were similar to those observed in runoff from developed areas with the exception of ammonia, which was low. The DP and TP concentrations for the KZE roof were near that of runoff from undeveloped areas while the concentrations at GRE were much higher. This difference could be due to fertilizer

applications or the roof medium. In both cases the proportion of DP was higher coming off of the green roofs.

The concentration of metals (Cd, Cu, Pb, Zn) in the green roof runoff was unremarkable, but it should be noted that roofing materials will have an impact on the metals concentrations. The following table details total levels of pollutants on both green roofs as compared to developed and undeveloped areas.

Table 1. Total Levels of Pollutants on Monitored Green Roofs KZE and GRE as Compared to Developed and Undeveloped Areas

Pollutant	KZE	GRE	Developed	Undeveloped
TSS (mg/l)	23.9	6.0	178.8	125.6
VSS (mg/l)	12.4	3.4	34.9	16.5
TOC (mg/l)	19.9	40.9	13.4	10.8
COD (mg/l)	61.6	98.2	80.0	39.9
NO_3+NO_2 (mg/l)	0.96	0.58	0.62	0.41
NH_3 (mg/l)	0.07	0.08	0.32	0.06
TKN (mg/l)	1.60	1.57	1.70	0.81
TN (mg/l)	2.16	2.05	2.27	1.20
DP (mg/l)	0.09	0.40	0.17	0.04
TP (mg/l)	0.18	0.47	0.40	0.12
Cd (µg/l)	0.07	0.07	0.56	0.54
Cu (µg/l)	8.13	5.90	15.3	5.18
Pb (µg/l)	17.0	0.23	23.9	3.87
Zn (µg/l)	50.0	28.5	106.8	20.4

Elevated concentrations of nutrients (defined as chemical elements and compounds found in the environment used in the growth and survival of plants and animals, such as nitrogen and phosphorus) in runoff from green roofs has been noted in the past and it has been hypothesized that there is an initial flush of nutrients from the roof but that it will decrease over time as the roof matures. Refer to graphs below that show the event mean concentrations of phosphorus (total and dissolved), nitrogen (total and nitrate + nitrite) and TSS over time as measured at the KZE roof.

There is quite a bit of variability in concentrations from storm to storm and there may be a slight downward trend in nutrient concentrations. However, there was an increase in 2008. TP appears to have more scatter than the other parameters. The decrease in concentrations is most notable in the latter part of 2009 and the first part of 2010 in the dissolved parameters (DP and NO_2+NO_3). This period coincides with the end of a drought and the reduction may be due to increased rainfall flushing the media; it is unknown at this time if the concentrations will return to the previous level with more normal rainfall patterns.

The KZE results appear to parallel those encountered in a green roof study by Penn State University for the US Environmental Protection Agency (EPA).[1] The authors of this work concluded that green roofs could significantly reduce the average annual stormwater runoff as compared with conventional roofs (with results very similar to the KZE roof) and that the runoff could contain high levels of nutrients such that additional polishing by vegetation (in ground-level landscaping, rain gardens, etc.) was recommended. The authors summarize the water quality findings as follows:

Runoff from green roofs had higher concentrations of most of the nutrients and ions evaluated. From the five precipitation events monitored, green roof runoff appears similar to what might be expected as leaching from any other planted system in the landscape…. Results indicate that a green roof will contribute more nutrients (except nitrate), hardness, salts, and other ions to the roof runoff, due mostly to the use of media and initial composting to provide nutrients for plants…. Increased loadings of some water quality constituents does not necessarily indicate that green roofs would increase loadings to receiving waters; however, this would suggest that the green roof as a stormwater BMP [Best Management Practice] should probably be integrated with other treatment techniques. Appropriate additional treatment, such as routing through a centralized BMP or more appropriately discharging from the downspout to LID [Low Impact Development] type BMPs, (e.g., swale, bioretention system, rain gardens) could be recommended for green roof runoff as a part of an overall stormwater system. Green roof runoff could also be collected and used for ornamental landscape purposes (p. 4-16).

The data results of the event mean concentrations of phosphorus (total and dissolved), nitrogen (total and nitrate + nitrite) and total suspended solids measured over time at green roof KZE are presented below.

[1] Berghage, Robert D. et al. *Green Roofs for Stormwater Runoff Control.* EPA/600/R-09/026. February, 2009. Pennsylvania State University. http://www.epa.gov/nrmrl/pubs/600r09026/600r09026.htm

Figure 1. Event Mean Concentrations of Total Phosphorus

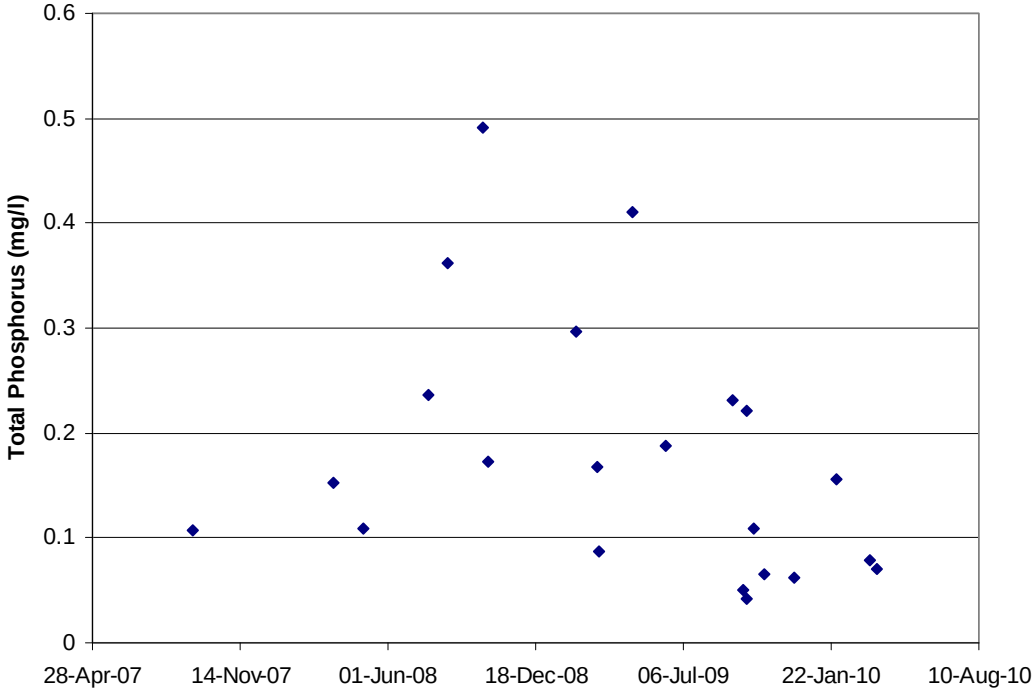


Figure 2. Event Mean Concentrations of Dissolved Phosphorus

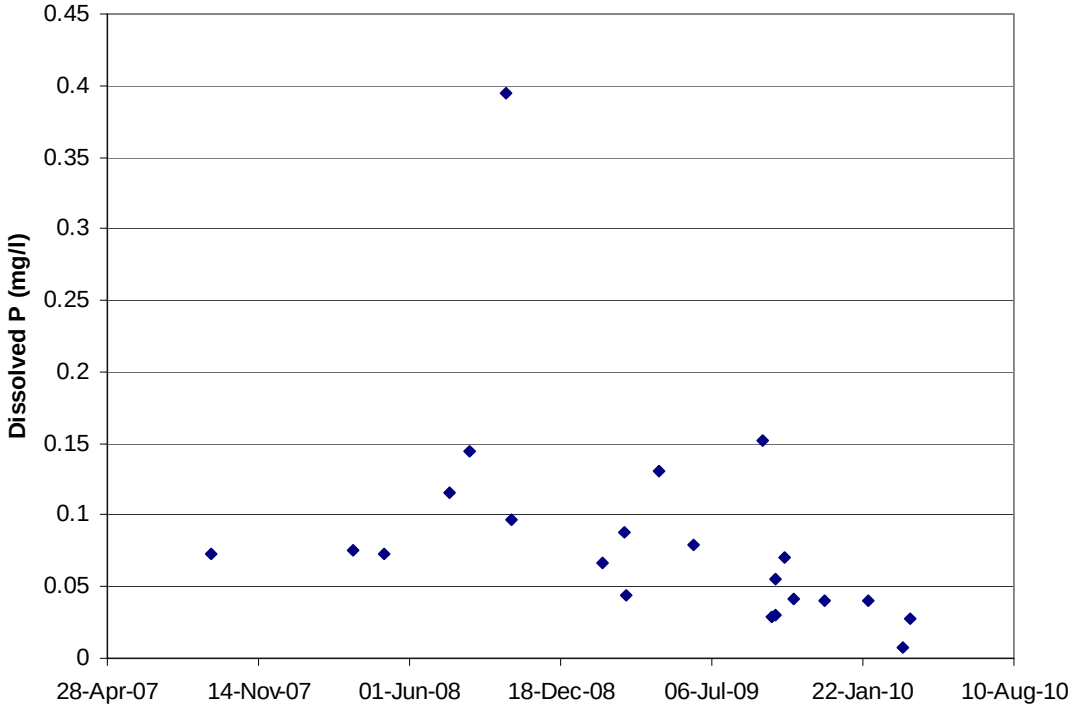


Figure 3. Event Mean Concentrations of Total Nitrogen

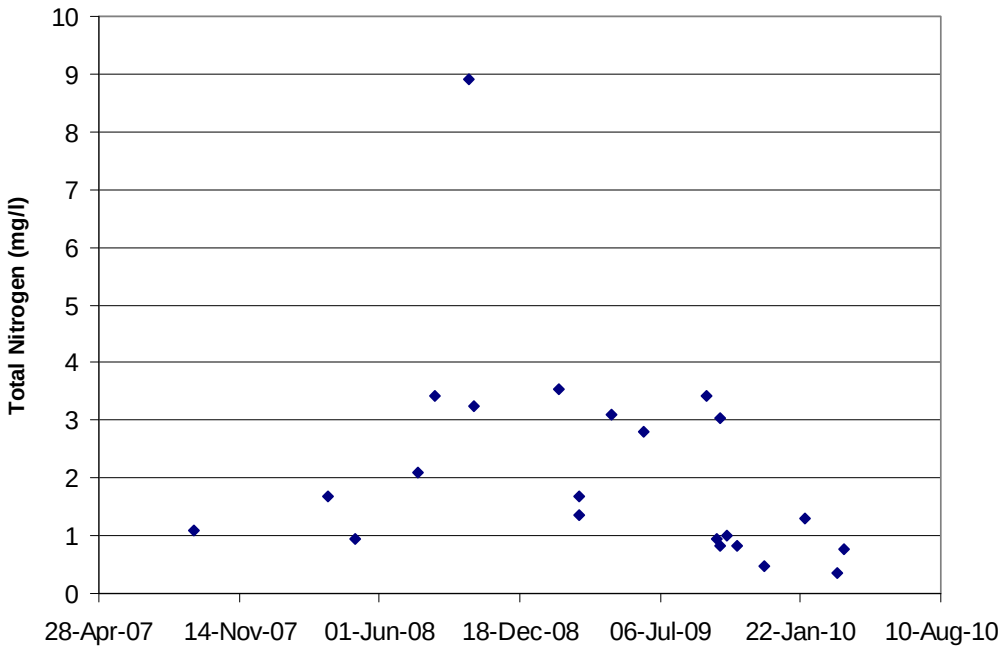


Figure 4. Event Mean Concentrations of Nitrate + Nitrite

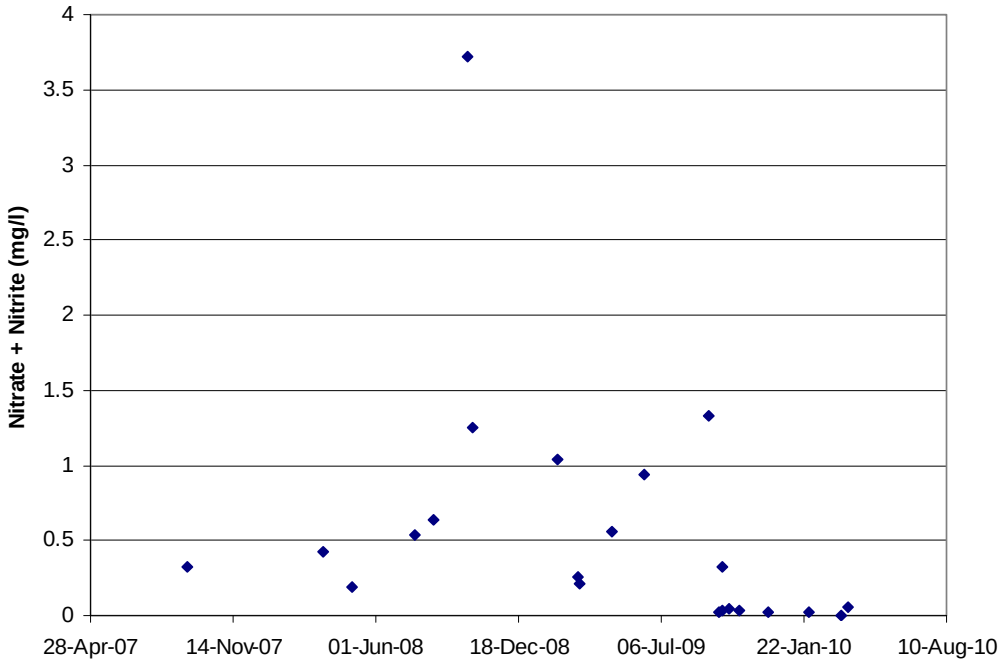
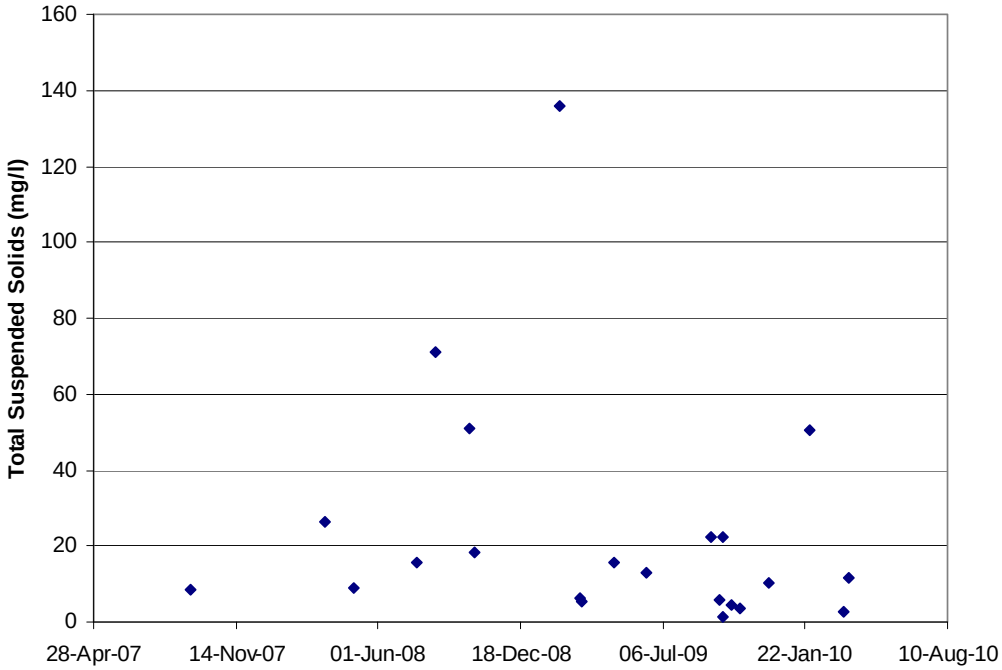


Figure 5. Event Mean Concentrations of Total Suspended Solids



Boston
- Rebate of $5.00/sf up to $100,000

Chicago
- Climate Action Plan for 6,000 green roofs by 2020. Over 2.5 million square feet of green roofs installed to date in institutional / commercial arena.
- Green Roof Grant Program – up to $5000 to residential and small commercial projects
- Density Bonus

Cincinnati
- Low interest loans for green roofs

Washington, D.C.
- Rebate of $5.00/square feet up to $20,000

Minneapolis
- 50% stormwater credit for strategies that increase quality of runoff
- 50% to 100% credit for strategies that decrease quantity of runoff

New York
- Tax Credit Incentives

Philadelphia
- Tax credit of 50% discount on stormwater charges for residences and businesses

Portland, OR
- All new City-owned buildings must have a green roof that covers at least 70% of the roof.
- Density Bonus
- 100% discount of site fee or 35% of total stormwater discharge fee based in management of roof runoff

Tempe, AZ
- Green vegetated desert roof counted toward LEED. (While this is not a city program, the green roof was installed on a city building.)

Toledo, OH
- Maximum credit of 50% for non-residential

Toronto
- Eco-Roof Incentive Program provides funding for qualifying green roof projects of $50 per square meter, up to a maximum of $100,000.
- Green Roof By-law requires all new institutional and commercial buildings to have green roofs. Graduated coverage chart applies.

Vancouver
- Density Bonus
- Credit for reduction of stormwater if integrated into Stormwater Management Plans
- Sewer System Fee Reduction
- Mandated requirement on 25% of roof areas in new sustainable development area

Virginia
- Reduction in permit fees
- Rate incentive based on stormwater reduction

MARKETING PROPOSAL
FOR GREEN ROOF EDUCATIONAL INITIATIVE AND WEBSITE

We propose the creation of a green roof educational campaign that will serve the larger Austin community including policy makers, residents, academia, and developers. It will be a resource for local Austin citizens and people doing business in the Central Texas region. Currently the City of Austin's Urban Heat Island Mitigation (UHIM) program exists primarily as an education and tree planting program, but this limited scope is the perfect foundation for an expanded green roof program. With Austin's progressive policies and programs in relation to mitigating the urban heat island effect through tree plantings, cool roofs, and eventually green roofs, Austin could once again be pushing the envelope and setting the bar for other cities to reach for.

Goal

Increase square feet of green roof space in Austin by a percent to be determined, and the local Central Texas green roof industry by a percent to be determined.

Value to The City of Austin and its Citizens

The value that The City of Austin and its Citizens will derive from the successful development of a green roof marketing plan will include, but are not limited to:

- Educating City staff, policy makers, residents, developers and business owners about the benefits of green roofs in Austin
- Providing an easily accessible source of information about existing incentives and policies available for green roofs
- Reducing the UHI effect, energy use, carbon foot print, providing space for wildlife, improving air quality, and reducing storm related runoff.
- Encouraging the development of a green roof industry in Austin, and supporting the City as "the most livable city in the world" which will help to attract people and business to Austin's unique, and beautiful community.

Objectives

- Support the City of Austin's goal as an environmentally progressive community.
- Support the City of Austin's vision as "the most livable city in the country."
- Educate public and private entities on the benefits of green roofs, and the challenges particular to Austin.
- Develop educational/marketing tools such as:
    - ✓ a comprehensive long term marketing plan;
    - ✓ a new Urban Heat Island Mitigation programmatic logo that is inclusive of the re-vegetation programs such as tree planting, and green roofs;
    - ✓ improved UHIM website and development of green roof specific web pages featured within the website.
- Current UHIM website can be found at www.cityofaustin.org/urbanheatisland.
- Outreach materials including a quarter sheet informational insert and an appropriate green roof themed outreach item.

Strategies & Deliverables

- Create a long term comprehensive educational/marketing plan for the Urban Heat Island Mitigation program with an emphasis on green roofs;
- Re-design the existing Urban Heat Island Mitigation website to feature re-vegetation programs currently happening in Austin, and to highlight an expanded section dedicated to green roof resources, Austin-centric green roof information, and the benefits and challenges of green roofs in Austin;
- Create a new inclusive UHI programmatic logo

- Educational Component:
  - ✓ Educational resource oriented towards policy and decision makers, City staff, and architects, engineers, and developers working in Austin and the surrounding area.
    - Website
    - Brochure or insert
    - Presentations to the public, City staff, and interested parties.

- Outreach Campaign:
  - ✓ The outreach component will promote existing incentives, best practices and green roof benefits specific to Austin.
    - Create outreach materials like a quarter sheet informational insert;
    - Production of an appropriate outreach item.

- Events:
  - ✓ Austin's Green Roof of the Year Awards @ the Environmental Awards event
  - ✓ Green Roof Challenge 2010 for residents
  - ✓ UHIM symposium for Central Texas

- Advertising:
  - ✓ Mailing Campaign to real estate, architect, policy makers, developers, engineers. Send letter, brochure and magnet. Invite to a speakers event and free luncheon.
  - ✓ Word of mouth
  - ✓ UHI – Green Roof Logo button on synergistic websites
  - ✓ Articles in local newspaper
  - ✓ Articles in ACPP and Green Building e-newsletter
  - ✓ Austin Energy's citywide distribution utility newsletter
  - ✓ Partner with weather reporters
  - ✓ Local advertising before movies featuring Urban Heat Island commercial.

Timeline

Year 1 (2011)	New green roof web component to the existing City of Austin Urban Heat Island website Create comprehensive marketing program - strategies for education and outreach, collateral, and partnerships.
Year 2 (2012)	Austin Green Roof Awards in conjunction with the Environmental Awards Program
Ongoing	Evaluation of goals and strategies of Urban Heat Island re-vegetation of Austin campaign.

GRAG COMMITTEES

Executive	Eleanor McKinney, Brian Gardiner, Matt Hollon, Maureen Scanlon
Site	Matt Hollon, Erin Wood, Abigail Webster, Kathy Zarsky, Blayne Stansberry, Eleanor McKinney, Fayez Kazi, Mark Simmons, Steve Windhager
Building	Maureen Scanlon, Norman Muraya, Leah Haynie, Lauren Woodward Stanley, Brian Gardiner, Dylan Siegler
Density Bonus Incentives	Brian Gardiner, Eleanor McKinney, Blayne Stansberry
Policy and Incentives Matrix	Matt Hollon, Maureen Scanlon, Eleanor McKinney, Blayne Stansberry, Dylan Siegler
Performance Matrix	Blayne Stansberry, Mark Simmons, Kathy Zarsky, Lauren Woodward Stanley, Peter Davis, Matt Hollon, Dylan Siegler
Community Outreach	Blayne Stansberry, Kathy Zarsky, Brian Gardiner
Five-Year Plan	Eleanor McKinney, Matt Hollon, Maureen Scanlon, Kathy Zarsky, Blayne Stansberry
Report Editing Graphics	Dylan Siegler, Blayne Stansberry, Leah Haynie, Maureen Scanlon, Eleanor McKinney

DESIGN CONSIDERATIONS DISCUSSION SUMMARY

Size

For a project to receive incentives and credits from the City of Austin, a certain percentage of the building footprint shall be designated as a green or vegetative roof. Higher percentages will correspond to higher credit green roofs. Further discussion and analysis is needed to determine the minimum percentages and whether percentages will impact construction costs for certain types of commercial developments that require minimum structural support, such as large indoor multipurpose spaces. It should be noted that the LEED Rating System offers credit for green roofs in Sustainable Sites Credit 7.2: "Install a vegetated roof that covers at least 50% of the roof area."

Soil Depth

There has been significant discussion regarding whether soil depth should be included in the design considerations or inherent in the design of the roof. Varying plant species require differing amounts of soil. For example, succulents may only need a few inches of soil where as a tree may require a few feet. Specifying a minimum depth may limit design creativity, especially on roofs where soil weight is problematic. In contrast, specifying a minimum soil depth will ensure plants have access to a minimum amount of water provided in the moisture holding capacity of the soil. It also provides the developer with a target early in the project design phase for conceptual analysis of the structural requirements and green roof components.

Plant Cover

Hardscape areas for pedestrian access typically accompany green roof design, particularly where the roof is utilized as amenity space. However, the amount of hardscape should not be excessive leaving minimal vegetation. Therefore, a minimum size or percentage of planting area should be specified. The planting area is the cumulative total of green roof areas suitable for plant growth, i.e., soil areas.

Plant Variety

The plants on a green roof should be drought tolerant and suitable for growth in the Central Texas climate. At a minimum, the plant varieties shall not include any species known to be invasive. The group identified the City of Austin Grow Green list of native and adapted species as a comprehensive list of suitable plants for green roof vegetation. A higher credit roof may strive to achieve restored native habitat by utilizing only native plant species.

Water Use

Supplemental irrigation will be needed for plant survival on a green roof during periods of drought. The irrigation requirements of a green roof are consistent with the irrigation goals of the Water Conservation 2020: Strategic Recommendations report dated March 2010. Furthermore, potable water use should, at a minimum, meet the irrigation requirements of LEED Water Efficiency Credit 1.1 or Austin Energy Green Building Rating Water Point 1a, both require fifty percent less potable water compared to a baseline system. A higher credit

roof may explore ways to achieve irrigation exclusive of potable water such as rainwater harvesting, HVAC condensate, or graywater.

Pest Management and Fertilization

A green roof should follow the typical standards set forth in an Integrated Pest Management Plan (IPM) for a traditional landscape. The IPM plan may be expanded to become an education tool for maintenance staff on the care requirements of a green roof. It would strictly control and minimize the use of pesticides, herbicides, and chemical fertilizers.

Stormwater Retention and Pollutant Removal

A green roof may potentially help meet City of Austin water quality or flood detention requirements. An engineer would need to demonstrate a reduced a curve number to indicate improved control of peak storm flows during flooding events. A green roof might be used to address water quality by serving as a component of a larger system to reduce runoff and pollutant export. For example, if an engineer could show the hydrologic response of the green roof is similar to 50 percent impervious cover rather than 100 percent impervious roof, credit might be considered to reduce the size of stormwater controls needed on the site. Additional analysis of the hydrologic response of green roofs is currently underway by the Lady Bird Johnson Wildflower Center.

Mulch

Mulch is an important component of the landscape design to minimize evaporation of water from the soil. Mulching on a green roof may include hard wood mulch or a lighter weight lava rock, among other options. Further discussion is needed to determine if a minimum depth of mulch should be specified in the design considerations to implement water conservation and plant health.

Visibility and Access

There are varying degrees of green roof access and visibility based on the use and function of the roof. A green roof may be visible from only a few windows within a building, visible from taller surrounding buildings, or visible to citizens on the street. Access varies similarly and a green roof can be privately or publicly accessible. A green roof may be accessible only by maintenance personnel. Access as a private amenity space may be provided only to tenants within a building. A green roof may also be used a public open space and accessible to the general public.

Maintenance Requirements

Access to a green roof for maintenance of plants, soil, and other rooftop equipment is critical. If a project receives credits or incentives from the City of Austin for a green roof, the project may be required to demonstrate maintenance responsibility, such as an operations and maintenance manual, landscape warranty, or restrictive covenant. Restrictive covenants may be required for projects where a green roof satisfies parkland or open space requirements.

Stakeholder groups contacted for their feedback on the interim report:

Associated Builders & Contractors, ABC
Associated General Contractors, AGC
American Institute of Architects Committee on the Environment, AIA COTE
American Society of Professional Engineers, ASCE
American Society of Landscape Architects, ASLA
Austin Contractors and Engineers Association, ACEA
Austin Econetwork
Building Owners & Managers Associates, BOMA
Capital Area Erosion Control Network, CAECN
Congress for New Urbanism, CNU
International Facilities Management Association, IFMA
Real Estate Council of Austin, RECA
Save Barton Creek Association, SBCA
Sierra Club
Save Our Springs (SOS) Alliance
Texas Society of Professional Engineers, TSPE
U.S. Green Building Council, USGBC

The following table comprises all comments received on the Green Roof Advisory Group Interim Report.

Comment Number	Comment Topic	Comment Date	How Received	Commenter	Comment
1	Stormwater	3/9/2010	Council Briefing	City Council	What are the water quality issues and concerns with green roofs? *Green roof research, both here in Texas and globally, have shown marked interception of most pollutants. However, this needs further examination to create guidelines that ensure high quality performance of all future installed green roofs.* *Furthermore, runoff from the green roof usually contains micro nutrients from the soil compost and should not be discharged directly to creeks. Runoff could be discharged in landscaped areas at grade landscape or recycled back up to the roof for irrigation.*
2	Vegetation	3/9/2010	Council Briefing	City Council	Will native vegetation be used? *Research here in Austin has already demonstrated that native & adaptive plants are well suited to work in this application.*
3	General	3/9/2010	Council Briefing	City Council	Will green roofs work in this climate? *Yes, with plant species that are adapted to the Central Texas climate and water efficient irrigation technologies.*
4	General	3/9/2010	Council Briefing	City Council	Have you reviewed Families and Children Task Force recommendations which includes green roofs for play areas? *Yes, a green roof could be designed to provide open space for play areas.*
5	General	3/9/2010	Council Briefing	City Council	What are the energy benefits of green roofs? *Green roofs are much more efficient that white reflective roofs in both winter and summer (even if the white roof is clean.) This is especially true for peak load, as the green roof protects the membrane during the typically highest energy demand. Austin Energy has determined a green roof is 9% to 13% more efficient than a white roof.*

Comment Number	Comment Topic	Comment Date	How Received	Commenter	Comment
6	General	3/9/2010	Council Briefing	City Council	Can you point to successful green roof projects here in Austin? Are you studying them to find out why they are successful? *City Hall is one successful project which includes multiple green roofs. GRAG recommends City Hall be studied. In addition, the Wildflower Center is currently studying vegetative roof plots and the City of Austin's monitoring program is collecting data on various green roof projects in the area.*
7	General	3/9/2010	Council Briefing	City Council	What are other cities doing? *Density bonuses and rebates are commonly used to incentivize green roof construction.*
8	General	4/13/2010	Council Briefing	Council Member Morrison	Are green roofs compatible with solar applications? *Yes, the solar panels can be set above the vegetation providing shade.*
9	Structural	4/21/2010	Interim Report	Rob Ledbetter, RPA Operations Manager Highland Mall General Growth Properties	Many roofs are not designed to handle the weight of soil and vegetation. Engineering studies will be required. *GRAG agrees.*
10	General	4/21/2010	Interim Report	Rob Ledbetter, RPA Operations Manager Highland Mall General Growth Properties	I disagree with the assessment of less foot traffic. HVAC units that are on the roof will still need to be serviced. The traffic will have to be confined to " paths" which will get more traffic verses an open roof. *Foot traffic will need to be confined to pathways that have the appropriate structural support.*

Comment Number	Comment Topic	Comment Date	How Received	Commenter	Comment
11	Irrigation	4/21/2010	Interim Report	Rob Ledbetter, RPA Operations Manager Highland Mall General Growth Properties	What about reusing the condensate for irrigation? I think the current plumbing code would need to be amended. *GRAG believes the use of condensate is appropriate for irrigation. The Austonian currently uses condensate for the amenity deck. The Water Conservation 2020 Report also reinforces the use of condensate water and recommends an amendment to the Plumbing Code.*
12	Maintenance	4/21/2010	Interim Report	Rob Ledbetter, RPA Operations Manager Highland Mall General Growth Properties	With the addition of soil and vegetation, the water runoff during heavy rains will have additional debris which could clog roof drains. *The green roof design will need to incorporate protective measures at roof drains to prevent clogging. Green roof systems are also designed with a layer of filter fabric between the soil and drainage layer to prevent the soil particles from entering the drainage system.*
13	Maintenance	4/21/2010	Interim Report	Rob Ledbetter, RPA Operations Manager Highland Mall General Growth Properties	All roofs will leak at some time. Having vegetation on top of the roof will make it harder and more costly to repair. *Technologies exist, such as Electronic Leak Detection (ELD), which easily pinpoint leaks. Although repair of a green roof may be more costly than a conventional roof, the soil and plant layers will lengthen the lifespan of the roof material reducing some of the typical life cycle costs.*
14	General	4/21/2010	Interim Report	Rob Ledbetter, RPA Operations Manager Highland Mall General Growth Properties	What about food service exhaust vents? Many will spew particles of grease which can make a mess. Vegetation may not grow near these vents. *GRAG agrees. Vegetation will not grow near grease vents and plantings should be setback a sufficient distance from the vents.*

Comment Number	Comment Topic	Comment Date	How Received	Commenter	Comment
15	Maintenance	4/21/2010	Interim Report	Rob Ledbetter, RPA Operations Manager Highland Mall General Growth Properties	Consideration will have to be given to maintaining clear access to all tie offs. There will also need to be area of no vegetation for window washing equipment. *GRAG agrees.*
16	Irrigation	4/21/2010	Interim Report	Rob Ledbetter, RPA Operations Manager Highland Mall General Growth Properties	The roof will need to be irrigated. Will the mandatory watering restrictions apply? *GRAG agrees. The green roof will be required to follow water restriction schedules.*
17	General	4/21/2010	Interim Report	Rob Ledbetter, RPA Operations Manager Highland Mall General Growth Properties	It appears that most of your advisory group is engineers and planners and is short of the folks who will have to deal with maintaining the roof and vegetation into the future. *GRAG appreciates the feedback you have provided. Although GRAG is made up of members with diverse skill, GRAG recognizes the group is not inclusive of all trades that would be involved in green roof infrastructure. GRAG continues to strive to reach out to all groups and welcomes comments and feedback.*
18	General	5/10/2010	Interim Report	Peter L. Pfeiffer, FAIA President Barley & Pfeiffer Architects	There are appropriate and inappropriate applications of green roofs, and they are not to be considered “the solution”. They are part of larger systems that must be integrated properly- just like anything else. A “should we” or “shouldn’t we” type of discussion on this topic is a bit unfair. An examination of circumstances, means and methods, performance, amenity, cost, etc. will inform the decision for consideration. *GRAG concurs.*

Comment Number	Comment Topic	Comment Date	How Received	Commenter	Comment
19	Stormwater	6/3/2010	written comment	Presentation Attendee	Revise all the storm water detention ponds to hold rain water for irrigation. *The function of a stormwater detention pond is to collect runoff from impervious areas and release the runoff slowly so that the creeks are not inundated with large volumes of runoff resulting in catastrophic flooding. Therefore, the ponds must remain empty to have the ability to intercept the large storm events as designed.*
20	Stormwater	6/3/2010	written comment	Presentation Attendee	Change structural codes to increase roof design loads to be able to hold green roof applications, even if not installed at the time of original construction. *Comment noted.*
21	Irrigation	6/3/2010	question & answer session	Presentation Attendee	Success of using condensate? *The Austonian's amenity deck is supplied with condensate for irrigation.*
22	General	6/3/2010	question & answer session	Presentation Attendee	Where can someone find green roof details and educational programs? *Green Roofs for Healthy Cities offers many resources and programs.* *Private consultants and Austin GRoWERS are local resources which offer more appropriate local/regional approaches.* *GRoWERS provides information for Do-It-Yourself.*
23	Water Quality	6/3/2010	question & answer session	Presentation Attendee	How do you ensure that organic matter and water infiltration are managed? *A layer of filter fabric is specified between the soil and drainage layer to prevent soil particles from entering the drainage system at the base of the green roof. Micro nutrients from the soil may still pass through the filter fabric. Therefore, the runoff should not be discharged directly into creeks or storm sewers. Refer to the response for comment #1.*

Comment Number	Comment Topic	Comment Date	How Received	Commenter	Comment
24	Maintenance	6/3/2010	question & answer session	Presentation Attendee	How do you address commercial concerns with extensive roof systems regarding the operational/maintenance strategy? *Design the system to the needs and capabilities of the facility management and educate about performance versus perception.*
25	General	6/3/2010	question & answer session	Presentation Attendee	Are brown roofs being considered? *Brown roofs have been discussed.*
26	General	6/3/2010	question & answer session	Presentation Attendee	Are large membrane manufacturers providing green roof complementary products? *Yes and new markets niches are emerging.*
27	Stormwater	6/3/2010	question & answer session	Presentation Attendee	Is there modeling and or other data being collected for any of the Austin roofs? *Yes, the Wildflower Center using a rainwater simulator to study quantity. The Wildflower Center also has past studies published for temperature, quality and quantity.* *A hill country residence is being monitored for quality and quantity which is discussed in this report. Refer to Appendix H.* *The City's Heat Island Mitigation Initiative will share reports and resources.*
28	General	6/3/2010	question & answer session	Presentation Attendee	Erosion & Sedimentation Control Network is a great audience for GRAG. *Many members of GRAG have attended and/or presented at the CAECN meetings.*

Presentations of the Green Roof Advisory Group final report were presented to the following Boards and Commissions.

Environmental Board, September 15, 2010
Resource Management Commission, September 21, 2010
Design Commission, September 27, 2010
Parks and Recreation Board, September 28, 2010
Planning Commission, September 28, 2010

The following table comprises all comments received from the Boards and Commissions at the Green Roof Advisory Group presentations.

Comment Number	Comment Topic	Comment Date	How Received	Commenter	Comment
1	Stormwater	9/15/2010	Environmental Board Presentation	Mary Ann Neely	Has GRAG considered testing for square foot vegetable gardens? *As we are working through the design considerations, GRAG will consider vegetable gardens. The local food movement is very strong in Austin and should be considered.*
2	General	9/15/2010	Environmental Board Presentation	Robert Anderson	Austin should encourage green roofs especially since we have a tougher climate with a lot of wind and heat. In particular, technical aspects of Green Roofs need to be explored and conveyed to the architectural community so they can see the benefits. If the private sector does not support and move forward green roofs, Austin will not get to where it needs to be. *Performance standards will consider the technical aspects of green roofs are noted in first year of 5 year plan. Education and outreach to the development community is also part of the first year.*
3	Access	9/15/2010	Environmental Board Presentation	Phil Moncado	A green roof for green space or parkland would need to be accessible by the public. *Yes, roofs that would be used to satisfy parkland requirements would require public access.*
4	General	9/15/2010	Environmental Board Presentation	Phil Moncado	Motion to extend GRAG for 1 year and recommend support of Five Year Plan.
5	Financial	9/21/2010	Resource Management Commission Presentation	Christine Herbert	The watershed studies have been funded but GRAG is a volunteer group, correct? *Yes, GRAG is a volunteer stakeholder group supported by City staff.*

Comment Number	Comment Topic	Comment Date	How Received	Commenter	Comment
6	Financial	9/21/2010	Resource Management Commission Presentation	Christine Herbert	Rebate discussions need to be multi-departmentally communicated and include water conservation and AE stakeholders. *GRAG includes staff members from Watershed Protection, Austin Energy Green Building, Austin Climate Protection Program, and Water Conservation.*
7	General	9/21/2010	Resource Management Commission Presentation	Leo Dielmann	Are folks from Building Permitting and Development on the GRAG as well? If they were a stakeholder in the process that would be preferable. *City staff has acted as liaisons with City departments, including meeting with Planning and Development Review to walk through the full 5 Year Plan, emphasizing the categories that would involve them. Much of what we've been examining together have been higher level zoning issues. Part of our work would be to continue to have that conversation with them.*
8	Financial	9/21/2010	Resource Management Commission Presentation	Christine Herbert	Is the reason Austin Energy commercial rebates didn't want to go ahead with rebates that they want to know what kind of program design we need, or why? *With the change in the energy code, reflective roofing is now required, where previously it garnered a $0.15/sf rebate. Energy code allows vegetated roofs to substitute for reflective roofing, but does not define the term. Part of our work is to define a vegetated roof in this context. Several studies show that the heat flux through a green roof is 50% less than a reflective roof; it shows less heat gain and loss. Reflective roofs still exhibit the peak effect where they reach a hotter temperature at the hottest time of the day; the curve is flatter when you look at the graph for a green roof. So instead of just starting at a $0.15/sf rebate for green roofs, we'd like to see the engineers go a little bit deeper. We have a GRAG member on the engineer group at Austin Energy and he is encouraging them to continue to investigate it.*

Comment Number	Comment Topic	Comment Date	How Received	Commenter	Comment
9	Water Conservation	9/21/2010	Resource Management Commission Presentation	Christine Herbert	Green roofs are very complex and involve added costs, and adding nonpotable water to the equation makes it even more difficult. *GRAG believes that the development of design considerations into Performance Criteria will help clarify this complex technology. In addition, green roof outreach and education is part of our Five Year Implementation Plan*
10	General	9/21/2010	Resource Management Commission Presentation	Christine Herbert	We have all this research and fabulous information. Are you going to be able to come in here in a year and tell us what it really takes to make green roofs work? *We already know that green roofs work in Austin based on existing examples, but the development of performance criteria will refine the definition of green roofs here.*
11	Financial	9/21/2010	Resource Management Commission Presentation	Leo Dielmann	Financial incentives may not be the answer; a number of incentives could be beneficial. *GRAG was tasked with investigating incentives and credits for green roofs, including financial and other incentives. In particular, we advocated for the inclusion of green roofs in the Density Bonus.*
12	General	9/21/2010	Resource Management Commission Presentation	Leo Dielmann	Move to support another year of work for the GRAG with quarterly updates to RMC.
13	Regulatory	9/27/2010	Design Commission Presentation	Richard Weiss	Will there be any new interim regulations supporting green roofs before the 1-year GRAG extension period is up? *Yes. The downtown density bonus program may include green roofs. A potential change to increase building cover maximums if green roofs are included may also be considered.*

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14	Incentives	9/27/2010	Design Commission Presentation	James Shieh	Other US cities are moving forward with incentives for green roofs, including provisions for flood detention and water quality credits. Will we see these in Austin sooner than later? Many could benefit from this right now. *Some cities have moved forward sooner than Austin. We have tended to want to see performance expectations proven up prior to allowing the incentives.*
15	Information sharing	9/27/2010	Design Commission Presentation	James Shieh	Will the City publish specifications and other information on green roofs? *Our expectation is that the private sector will largely fill this role. But the City could assist, such as posting such information on the web. An Austin group, soon applying for nonprofit status, called GRoWERS is working on disseminating information on residential green roof applications.*
16	Cost	9/27/2010	Design Commission Presentation	Bart Whatley	What is the cost of green roofs compared with those for stormwater controls? *It depends on many factors, such as the use of extensive vs. intensive green roof systems: a 6-inch profile for a prairie installation vs. a 5-foot depth for a large tree. Locations with high land prices, such as downtown, will benefit more from green roof stormwater controls, since this may mean avoiding using high-priced land for stormwater detention or water quality. Green roofs might be used as part of a stormwater management "treatment train." It is preferable to have a system, such as a green roof, out in the open rather than use an underground vault with a pump, as are often used in dense urban applications now.*

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17	Cost-Benefit	9/27/2010	Design Commission Presentation	David Knoll	What is the price per square foot for green roofs? This would be a key consideration for the density bonus, to weigh the tradeoffs and allow a developer to see if it would work for them. *The developer would already know what the stormwater ponds would cost. Avoided cost to not have to build this pond would be factored into the green roof. Costs for green roofs vary considerably, but a rough estimate would be $15 to $30 per square foot, not including increased structural support costs.* I encourage you to bring in more cost-benefit analyses to your work. With the stacked [multiple] benefits, it would show the value for the density bonus.
18	Maintenance	9/27/2010	Design Commission Presentation	James Shieh	There are now many green roofs around town. You should ask the owners about their maintenance. This maintenance falls to the owners and could be great. What if the roof gets a leak? How long will the membrane last? Should owners set aside money like a Homeowners Association for future maintenance? Will the roof need to be ripped out 15 years later? *The green-roof overburden protects the waterproofing layer. After inspection, they have appeared practically brand new after years of use (as opposed to conventional roofs which show wear immediately upon installation due to exposure to the sun and elements). But the membranes for green roofs must be carefully inspected upon installation. Once done, they are better protected and last much longer.*

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19	Maintenance	9/27/2010	Design Commission Presentation	James Shieh	Have you looked at historical failures of green roofs? *A new technology called electronic vector mapping can be employed to pinpoint the position of leaks. These systems are installed with the green roof systems. They allow much more targeted leak detection. Flashing details are also available for best installation. Note also that stormwater controls must also be maintained over time. We would expect the same for green roofs if used for stormwater control. This will be an element considered during the performance standards analysis. Essentially, with a green roof, you are transferring at-grade maintenance to the roof; landscape would need maintenance in either location. Extensive green roofs generally cost less to maintain than intensive green roofs. The level of presentation also affects maintenance cost.*
20	General	9/27/2010	Design Commission Presentation		Motion to extend GRAG for 1 year and recommend support of 5-year plan with a recommendation to add a cost-benefit analysis to the performance standards work. Motion supported unanimously.
21	General	9/28/2010	Parks and Recreation Board Presentation	Sara Marler	There are new buildings being planned on parkland (boathouses, etc.). Should there be more incentive for these projects to include a green roof than other City projects? *GRAG recommends evaluating the feasibility and funding of green roofs for all new City buildings in the Five-Year Implementation Plan. GRAG agrees that green roofs would be especially beneficial on parkland as a green roof would allow taken parkland to be replaced with open space. The conceptual plan for the Waller Creek Tunnel inlet in Waterloo Park includes a green roof option, although the plan has not been finalized.*

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22	General	9/28/2010	Parks and Recreation Board Presentation	Carol Lee	What resources does the City have available to review opportunities for green roofs on new PARD buildings? *Peter Davis with the Public Works Department will be evaluating the feasibility and funding for green roofs on future City projects. Including a green roof on a City building can help the project to comply with Council Resolutions requiring new City buildings to achieve a LEED Silver Rating (20071129-045) and incorporate green infrastructure (20071129-046).*
23	General	9/28/2010	Planning Commission Presentation	Jay Reddy	Is the capital extension north of the State capital building, which is all underground, considered a green roof? *Yes, green roofs are NOT just above ground, above below grade structures (ie. underground parking lots) per the definition of green roofs as defined by "Green Roof's for Healthy Cities" (Toronto, Canada). Austin's City Hall also has a green roof that is above a below grade structure (parking garage).*
24	General	9/28/2010	Planning Commission Presentation	Jay Reddy	Do you know of anybody in Austin or anywhere else doing a green roof on a stick frame building? *Yes, the Stanley Studio shown the Green Roof Report is built on a stick frame. GRoWERS, an advocacy group seeking non-profit status, is an organization supporting residential green roofs in the Austin area. They are taking action to lighten the depth of soil, which would aid the construction of green roofs on stick frames.*
25	General	9/28/2010	Planning Commission Presentation	Mandy Dealey	Compliments the presentation of the report and congratulates GRAG on its achievements. *Eleanor McKinney thanks Leah Haynie, urban heat island, and Dylan Siegler, and Blayne Stansberry who did the editing of the report.*

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26	General	9/28/2010	Planning Commission Presentation	Mandy Dealey	What would you like for us to do to support this going forward? *Advocate and support the GRAG extension for a year, especially for the performance standards and implementation of the 5-year implementation plan.*
27	Zoning and Impervious Cover Limitations	9/28/2010	Planning Commission Presentation	David Anderson	During the Star Riverside project, on the northeast corner of I-35 and Riverside, questions about impervious cover limitations for underground parking lots came up. Will the effect on underground parking lot impervious cover limitations be addressed in these early phases of the green roof policy development or is it something that will be considered later down the road? *Appendix D [later A] in the Green Roof Report talks about zoning and impervious cover limits. We looked at this exact ordinance section that was sparked by the Star Riverside project. Exploration into changing the section was considered, but staff decided to not support altering the current ordinance. However, for projects like the Star Riverside, the report directly addresses the situation stating, "Subsurface parking structures are considered pervious if the average soil depths are 4-ft and the minimum depth is 2-ft. It applies only within the urban roadway boundary and it does not apply in the Barton Springs' Zone…". So you could build a green roof using that ordinance and it would not count as pervious cover. But it could only be used in those limited locations in the city; but the code does exist currently. This is representative of many items that our effort uncovered where code changes were not needed to implement a green roof construction to fulfill City requirements.*

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28	Density Bonus Plan	9/28/2010	Planning Commission Presentation	David Anderson	The level of detail provided in the previously mentioned section is the level of detail the commission needs for this to work. Commissioner commends the efforts of GRAG of identifying opportunities for green roof implementation outlined in the current city code, because there are lots of them. *Reiterates support for green roofs as an option in the Downtown Density Bonus Plan.*
29	General	9/28/2010	Planning Commission Presentation	Jay Reddy	Motion to extend GRAG for 1 year, support implementation of the Five Year Plan, support the addition of green roofs as a standalone density bonus option in the Downtown Austin Plan, and support consideration of a green roof on the new Central Library.
30	General	9/29/2010	Parks and Recreation Board Presentation	Linda Guerrero	The Board will draft a letter of support to approve at the next meeting.